


Intracranial Pressure (ICP) Causes, Concerns and Management

Neurosurgery Education
and Outreach Network

NE  N

The Neurosurgery and Education Outreach Network (NEON)

- The Neurosurgery Education and Outreach Network (NEON) is comprised of Neurosurgical Nurse Educators (NNEs), Clinical Outreach Specialists/Advanced Practice Nurses and hospital Administrators dedicated to the neurosurgical nursing program implementation and on-going educational and clinical support of nursing staff in the neurosurgical centers and the non-neurosurgical referral centers.
- As a neurosurgical educational support program, NEON reports directly to and works in conjunction with Critical Care Services Ontario (CCSO) and the Provincial Neurosurgery Advisory Committee who supports system wide improvements for Ontario's neurosurgical services.

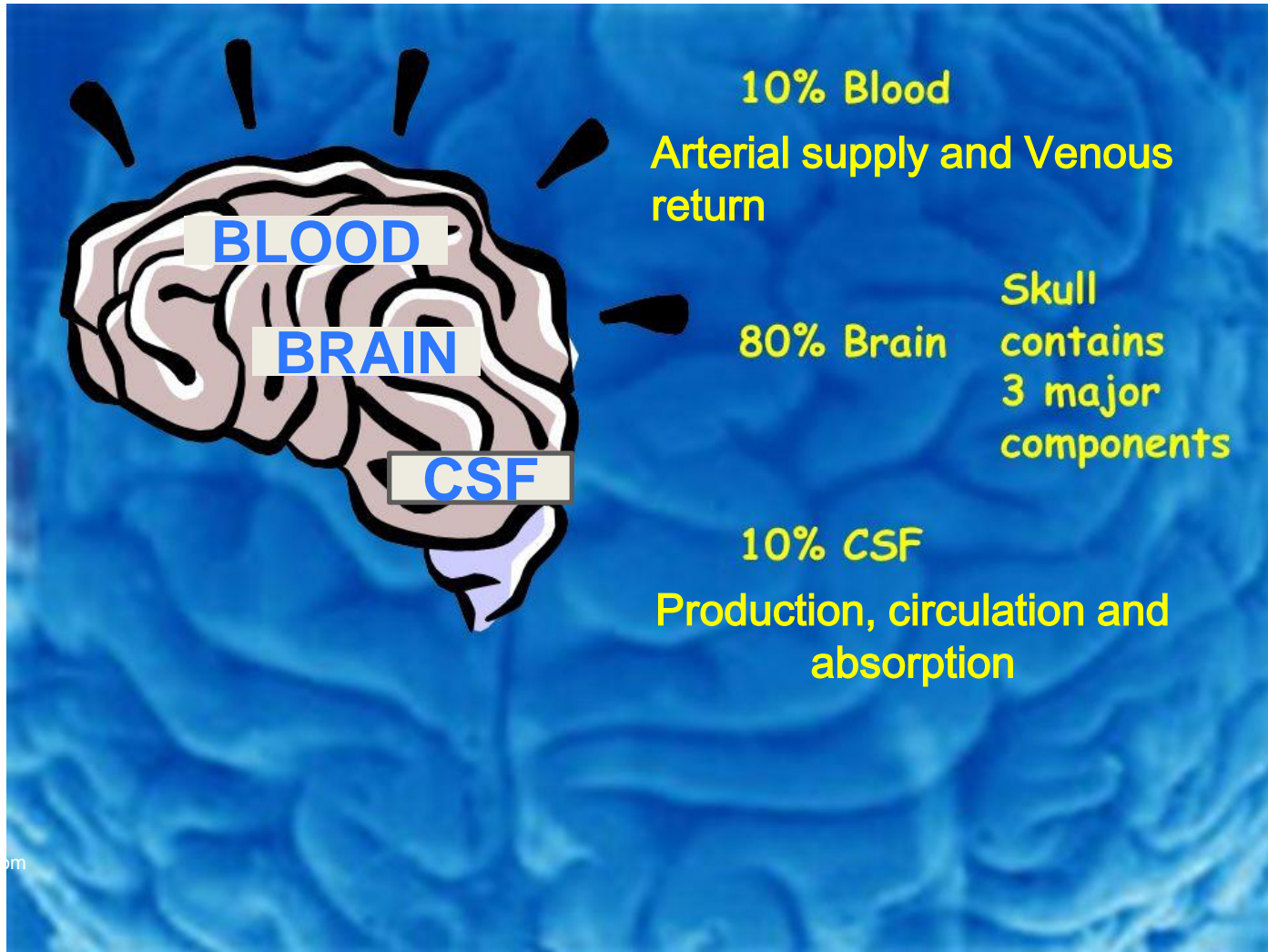
Disclosure Statement

- The Neurosurgery Education and Outreach Network (NEON) and Critical Care Services Ontario (CCSO) have no financial interest or affiliation concerning material discussed in this presentation.
- This presentation provides education on the topic based on nursing best practice and management. It was developed by a sub-group of clinical neurosurgical nurses and neurosurgical educators for Registered Nurses (RN) across Ontario. This presentation is not meant to be exhaustive and its contents are recommended but not mandated for use. RNs should use their clinical judgment and utilize other assessment parameters if determined necessary.

Objectives

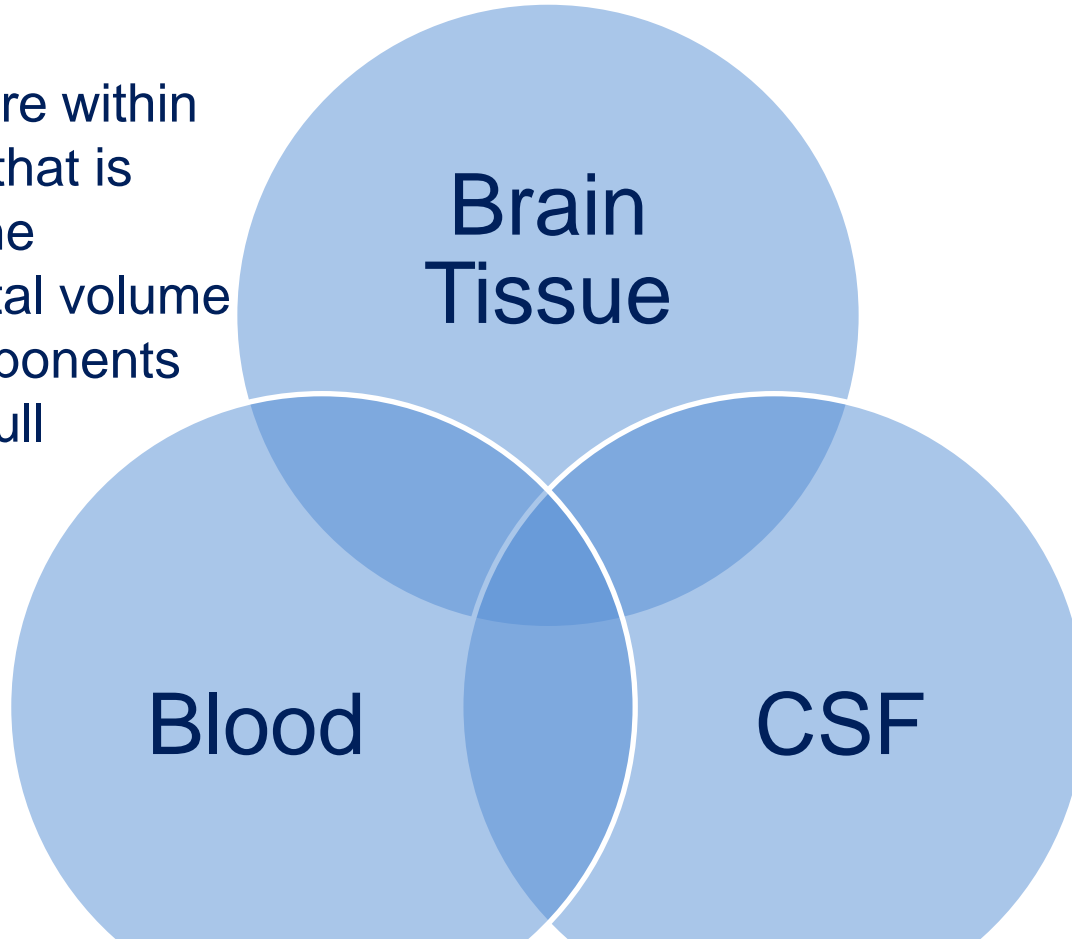
- Identify the components of the Cranial Vault
- Identify the components of Intracranial Pressure (ICP)
- Identify the causes of rising Intracranial Pressure
- Identify the treatments of rising Intracranial Pressure
- Identify transfer of patients because of rising Intracranial Pressure to a neurosurgical center

Anatomy and Physiology



What is ICP?

...the pressure within the cranium that is exerted by the combined total volume of the 3 components within the skull



MONROE-KELLIE DOCTRINE

Monroe-Kellie Doctrine

- Brain tissue , blood volume and CSF volumes are in a state of dynamic equilibrium
- If an increase occurs in any of the above, the volume of one or more of the other components must decrease or an elevation of ICP will result



<https://thebyproduct.com/2012/10/04/the-scale/>

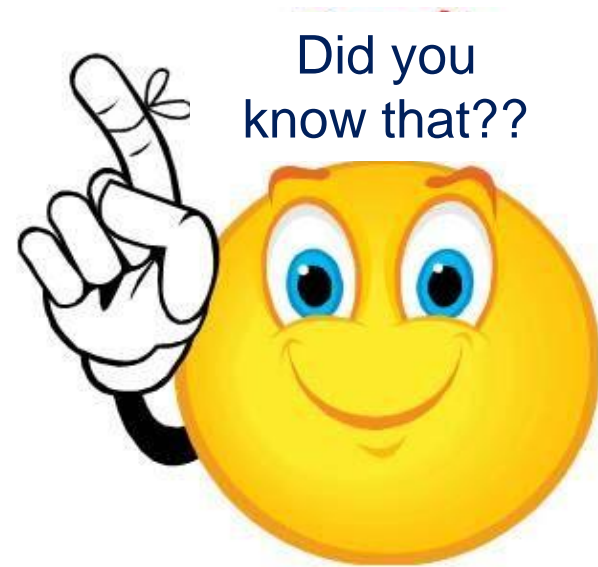
Elevated ICP

- ICP can become elevated for various reasons in response to disease, environment, emotion and normal bodily functions
- Factors can be non-pathologic or pathologic in nature
- These can cause slow elevations or rapid increases in ICP

Elevated ICP

Non-pathological causes include:

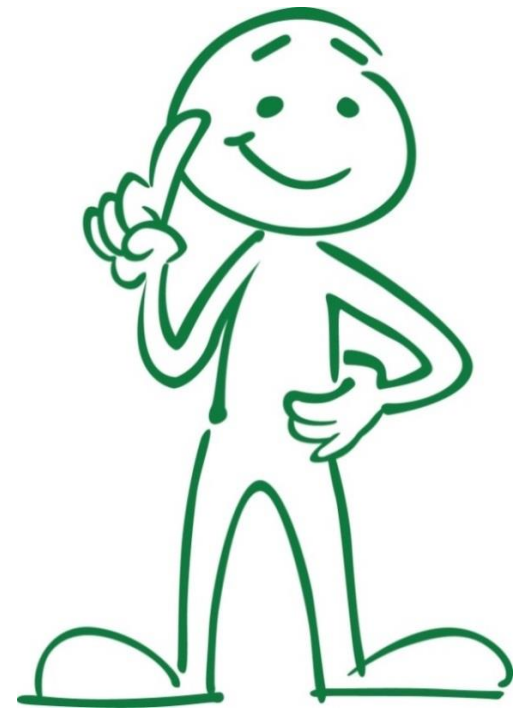
- Coughing
- Sneezing
- Lifting
- Bending
- Valsalva (bearing down)
- Stress
- Blood pressure changes
- Emotional responses
- Body positioning



Elevated ICP

Pathological causes include:

- Concussion
 - Contusion
- Traumatic Brain Injury
- Subdural Hematoma
 - Epidural Hematoma
 - Subarachnoid Hemorrhage
 - Hydrocephalus
 - Tumour
 - Edema
 - Abscess or Infection
- Space Occupying Lesions



Elevated ICP

Primary factors that influence elevated ICP include:

- Blood pressure
- Heart function
- Intra-abdominal/Intrathoracic
- Temperature
- Pain
- Carbon Dioxide/Acidosis
- Hypoxia



Why is it Important?

- Maintaining cerebral perfusion pressure is the main focus in management of cerebral injuries that impact the 3 components in the central system- brain/blood/CSF
- CPP is calculated using the Mean Arterial Pressure (MAP) and Intracranial Pressure (ICP)
- $CPP = MAP - ICP$
- What if you don't know the ICP?

Why is it Important?

- Normal CPP 60 to 100 mmHg
- Goal is to maintain a minimum of 60mmHg for brain injuries
- Cerebral Perfusion Pressure (CPP) values of:
 - **>150** disrupts the blood brain barrier and causes hyper-perfusion and potentially brain edema / swelling. This could potentially lead to herniation syndrome
 - **<50** causes hypo perfusion and brain ischemia
 - **<30** causes irreversible ischemia/ damage

Who Can Do This?

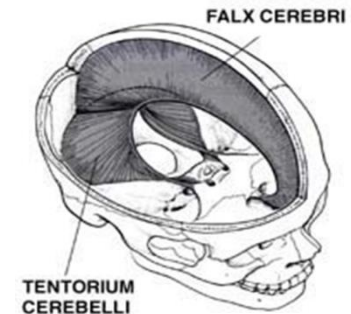
- Monitoring of the neuro assessments, including vital signs, can be done everyday by nurses
 - Ensuring systolic blood pressure is within a consistent range will improve perfusion
- Achievable in both neurosurgical center or non-neurosurgical center

Compensatory Mechanisms to Maintain Adequate Flow to the Brain






S & S of Increased ICP Depend On.....

- Compartmental location of lesion (supratentorial or infratentorial)
- Specific location of mass (cerebral hemispheres, brain stem or cerebellum)
- Degree of intracranial compensation (compliance)



S+S of Increasing ICP

Patient Presentation:

-  LOC (subtle)
-  Motor function
-  Restlessness
- Nausea & vomiting
- Sensory deficits
- Headache
- Visual changes
- Seizures
- Pupil changes

Vital Signs:

- Elevated BP with no obvious cause
- Rising systolic pressure
- Widening pulse pressure
- Bradycardia



Cushing's Triad

1

- HYPERTENSION
- Pulse Pressure Widens

2

- BRADYCARDIA

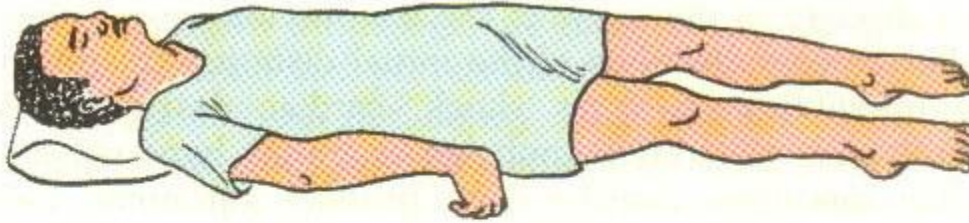


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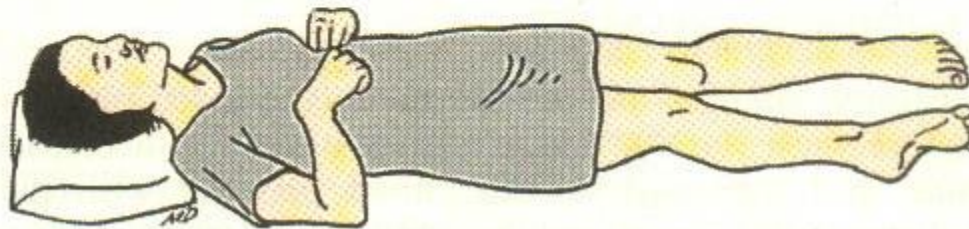
- IRREGULAR RESPIRATIONS

.....Late Signs

Consequences of Prolonged Elevated ICP



A. Extension posturing (decerebrate rigidity)



B. Abnormal flexion (decorticate rigidity)

- Cerebral ischemia and stroke
- Irreversible brain damage and cerebral hypoxia
- Permanent physical disability
- Brain herniation and brain death

What Can Be Done to Lower ICP?



Eliminate Things That Elevate ICP

- Reducing stimulation
 - Space out nursing care
 - Fewer tasks, spread out
 - Explain to family importance of a quiet visit (limiting stimulation)
- Severe hypertension
 - Don't routinely reduce this as permissive hypertension be neuroprotective
- Anemia
- Seizures



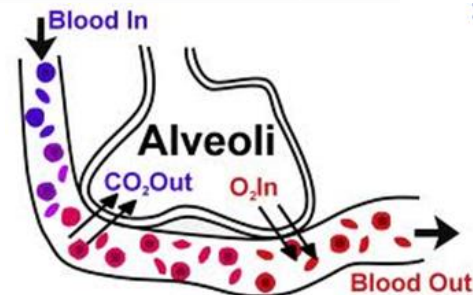
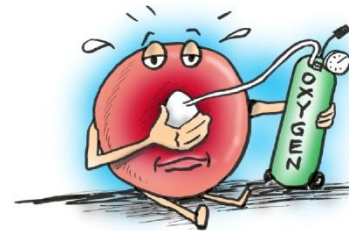
<https://www.healthtap.com/>

Eliminate Things That Elevate ICP

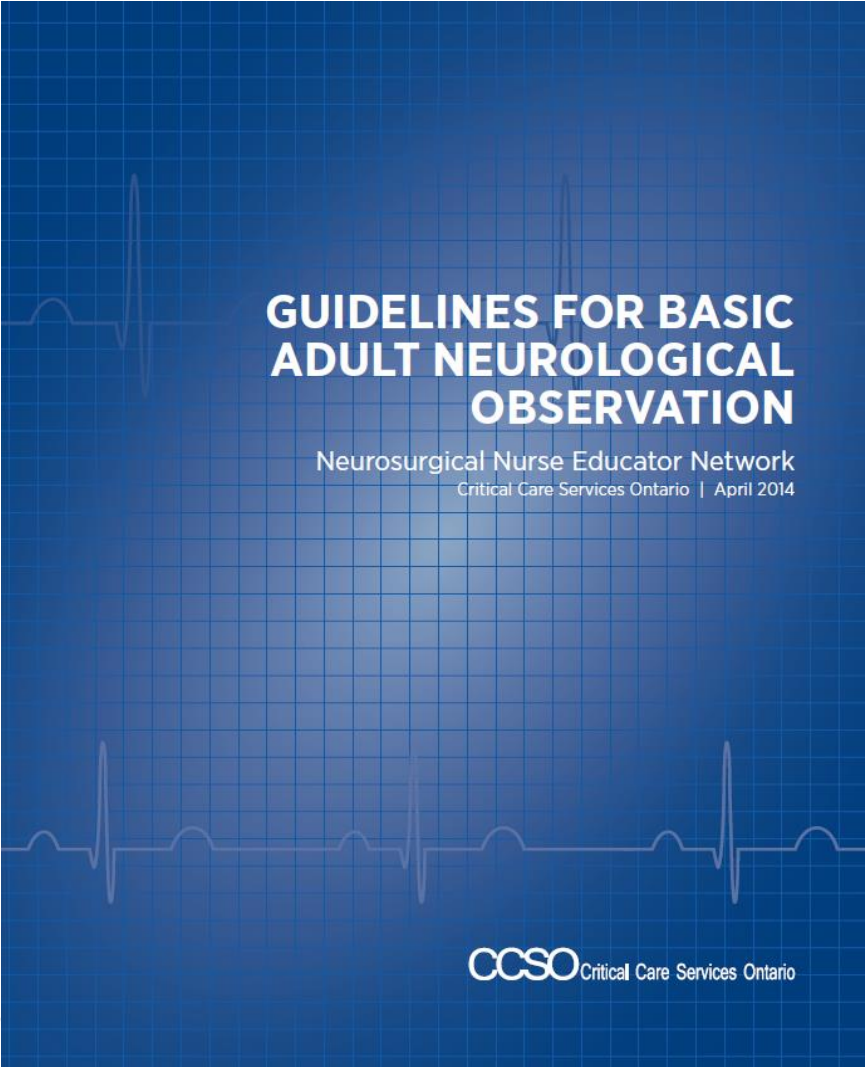
- Control intra-thoracic pressures
 - Minimizing airway stimulation (coughing)
 - Pharmacological agents (Propofol?)
 - Minimizing positive end-expiratory pressure [PEEP]
 - Gastric decompression
- Fever
 - Cool (Tylenol, cooling blankets)

Eliminate Things That Elevate ICP

- Obstruction of venous return
 - Head positioning – align, elevate
 - Agitation
- Respiratory problems
 - Airway obstruction
 - Hypoxia
 - Hypercapnia



Neurological Assessment



GUIDELINES FOR BASIC ADULT NEUROLOGICAL OBSERVATION

Neurosurgical Nurse Educator Network
Critical Care Services Ontario | April 2014

CCSO Critical Care Services Ontario

- Consistent approach
- Facilitates the identification of neurological change
- **Basic components:**
 - GCS
 - Pupils
 - Motor responses
 - Motor strength
 - Vital signs

Neurosurgical Consultation

MRP or ED and connect with a Neurosurgeon via CritiCall if deteriorating status has been detected by:

- Deteriorating neurological assessments (GCS + Pupils+ Movement + Vital signs)
- Repeat imaging
- Deteriorating clinical picture

Acute Neurosurgical Consultation Guidelines

Developed by Dr. Sunjay Sharma, Dr. Avery Nathens, and Dr. James Rutka for Provincial Neurosurgery Ontario



Connecting physicians, resources and care 1 800 ONT HELP (668-4357)



In all cases, ABC's should be evaluated and treated prior to the application of these guidelines.

1 Identify patients eligible for acute transfer

Acute transfer is most often required if a patient meets at least 1 clinical *and* 1 imaging criteria from the lists below:

Clinical criteria

- Penetrating head injury
- Altered LOC not attributable to intoxicants
- High ICP (nausea, vomiting, headache) with altered LOC
- Seizures
- Focal Neurological Deficit (cranial nerve or motor deficit)
- Lateralizing signs (e.g. pupillary dilatation, hemiparesis)

Imaging criteria

- Traumatic intracerebral, acute subdural, or epidural hematoma
- Brain contusion
- Non traumatic brainstem or cerebellar intracerebral hemorrhage (ICH) (Non traumatic cortical ICH if a vascular malformation is suspected)
- Penetrating cranial object
- Hydrocephalus
- Non traumatic subarachnoid hemorrhage
- Mass Lesion (posterior fossa lesion, midline shift >3mm, hemorrhage within tumor or significant peri-lesional edema in lesion >3cm)

Unique circumstances that might mandate transfer in absence of access to imaging

- Lateralizing signs & GCS ≤ 8 in institution without access to CT scan
- LP proven subarachnoid hemorrhage (presence of xanthochromia)



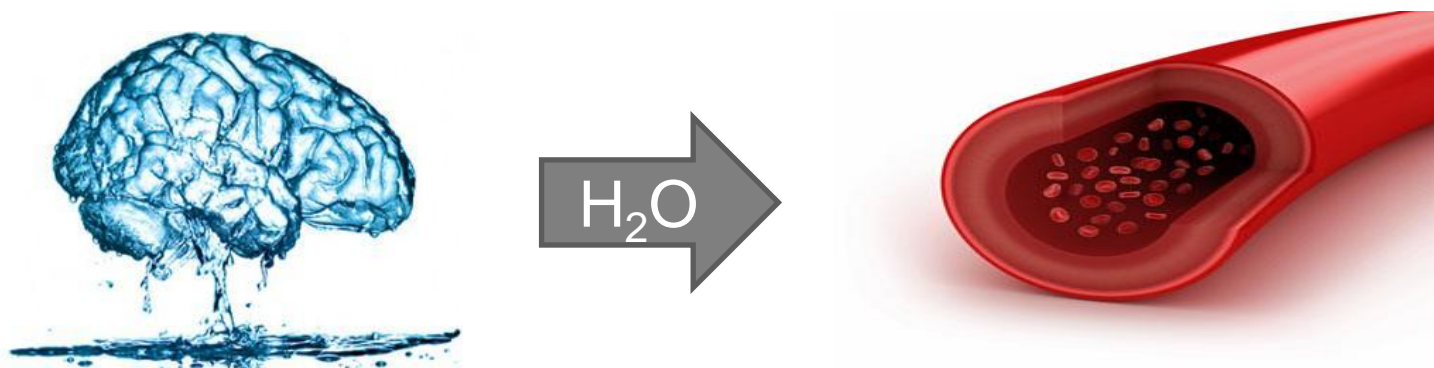
If criteria in first step are satisfied, there should be a reasonable expectation of discussion regarding patient transfer.

Higher Level of Care

- Injuries with pathological causes previously mentioned
- Patients with head injuries- severe TBI or deteriorating mild to moderate
- Posterior fossa tumours? Injuries?
- Third ventricle tumours (colloid cysts)
- Pineal tumours (compression of cerebral aqueduct)
- SAH with associated communicating hydrocephalus (arachnoid villi become plugged)
- Non communicating hydrocephalus

20% Mannitol

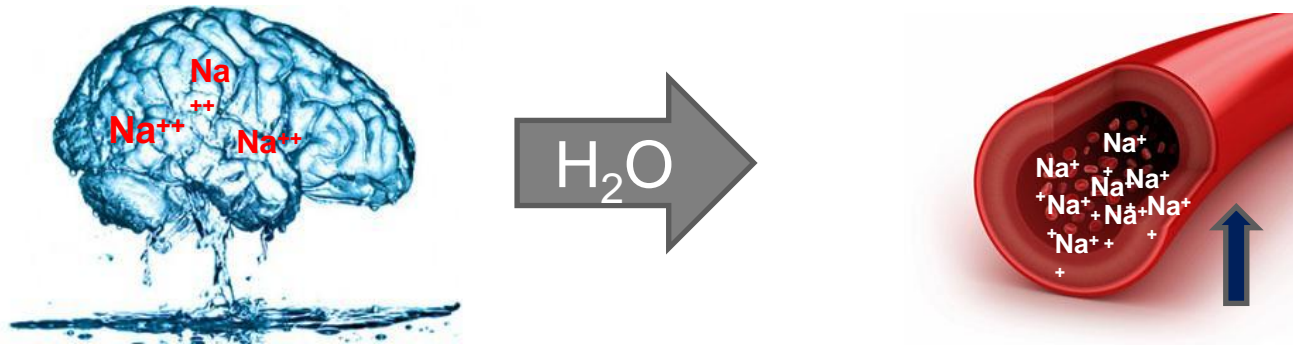
- Mannitol decreases cerebral edema by removing water rapidly through diuresis



- The hypertonic concentration draws water from the brain and opens the kidneys. This draws water out of the brain, decreasing brain edema and lowering ICP
- Causes rapid fluctuations in serum electrolytes and hydration with large amounts of urine output

Hypertonic 3% NaCl

- Water moves by osmosis to the area of greatest Na concentration



- Hypertonic 3% NaCl administration increases sodium in the blood. This draws water out of the brain, decreasing brain edema and lowering ICP
- Slower process with > consistent decrease in brain edema

Other Considerations

- Narcotics and sedatives:
 - Be judicious in their use
- Avoid large fluctuations in blood pressure:
 - Hypotension decreases the MAP and cerebral perfusion
- Keep oxygen up:
 - Hypoxia alters LOC and robs the brain of needed oxygen to function and heal

Other considerations

- Carbon Dioxide is the enemy:
 - Hypercarbia causes neurological decline
 - Avoid CO₂ Narcosis!
- Think nutrition:
 - A hypermetabolic brain requires more protein to heal
 - Feeding may be necessary in short term
- Blood sugar fluctuations:
 - Avoid hypoglycemia

Other considerations

- Fever can influence neurological exam:
 - Normal temperature is the goal
 - Treat fevers
- Admission date/time:
 - Peak swelling of cerebral edema can be 3-5 days before it decreases
 - Frequent NVS assessments trend the status during this swelling time as it increases and begins to fade

Summary

- Rises in Intracranial Pressure (ICP) can occur after any brain injury, mild to severe
- Maintaining adequate cerebral perfusion is the goal
- Serial neurological assessments with documentation of the neurological trending can detect the rising ICP
- Transfer may be necessary for higher level of care and neurosurgical interventions

Your Role

- ✓ Do what is within your scope!
- ✓ Conduct neuro-vital sign checks more often to detect, document and identify the trend in status
- ✓ Enact nursing interventions to decrease ICP
- ✓ Communicate
- ✓ Be persistent
- ✓ Work with MD to treat underlying causes
- ✓ Support family
- ✓ Document

Web-links

- Critical Care Services Ontario
– www.criticalcareontario.ca

CCSO Critical Care Services Ontario

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- Critical Care Nursing
- Surge Capacity Management
- Implementing Life or Limb Policy
- Repatriation
- Trauma and Burns Consultation Guidelines
- Epilepsy Guideline Series
- Neurosurgical Care
- Archives

Access
Ontarians should have access to timely, appropriate and equitable health care services, regardless of who they are and where they live, in order to achieve the best possible health outcomes.
[More...](#)

Quality
All Ontarians should receive the highest standard of health care based on proven medical practice and knowledge.
New [CCRT Training Program](#)
[More...](#)

System Integration
The province's health system should support seamless transitions between inter-disciplinary and cross-functional health care providers throughout a patient's continuum of care.
[More...](#)

Value
The ability to attain greater efficiency and quality of care in a manner that also optimizes patient outcomes is crucial to the continued development of the critical care system.
[More...](#)

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Questions and Answers

THANK YOU!



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Open until December 6 2016



THANK YOU!

CCSO Critical Care Services Ontario
www.criticalcareontario.ca

References

- American Association of Neuroscience Nurses. (2011). *Nursing management of adults with severe traumatic brain injury: AANN clinical practice guideline series*. Glenview, Illinois.
- Critical Care Services Ontario (2016). Provincial Acute Neurosurgical And Spine Consultation Guidelines. retrieved from <https://www.criticalcareontario.ca/EN/Library/Neurosurgical%20Care/Pages/default.aspx>
- Hickey, J. (2003). *The clinical practice of neurological and neurosurgical nursing* (5th ed.). Philadelphia: Lippincott.
- Marcoux, K. (2005). Management of increased intracranial pressure in the critically ill child with an acute neurological injury. *AACN Clinical Issues*, 16(2), 212–231.
- Tymianski, D., Sarro, A., & Green, T. (2012). *Navigating Neuroscience Nursing: A Canadian Perspective*. Pappin Communications. Pembroke. Ontario
- UpToDate. (2012). Evaluation and management of elevated intracranial pressure in adults. Retrieved from: www.uptodate.com
- Woodward, S., & Mestecky, A. (2011). *Neuroscience nursing: Evidence-base practice*. Malaysia: Wiley-Blackwell